[002] This application claims priority from German Application Serial No. 103 05 157.0 filed February 8, 2003.

[003] FIELD OF THE INVENTION

[004] The invention concerns an electromagnetic dual-action control valve ~~according to the preamble of Claim 1~~.

[005] BACKGROUND OF THE INVENTION

[010] ~~This objective is achieved by the characteristics of the principal claim, while advantageous further developments and design features of the invention emerge from the subordinate claims.~~

[011] SUMMARY OF THE INVENTION

[023] BRIEF DESCRIPTION OF THE DRAWINGS

[024] ~~For better understanding, the invention is explained~~ The invention will now be described, by way of example, with reference to ~~an example embodiment illustrated in~~ the ~~attached drawing,~~ accompanying drawings in which ~~shows~~:

[034] DETAILED DESCRIPTION OF THE INVENTION

[037] At the end of the hollow armature ~~[[11]]~~ 4 facing away from the spring 7, the armature has a largely closed end 11 which, in this case, has only one opening 21 to allow passage of the pressure medium. In addition, a further opening 20 can be seen in a sidewall 38 of the hollow armature 4, through which the pressure medium can flow out of the hollow space of the hollow cylinder 4 into the inside space 28 of the valve housing 2.

[038] The dual-action control valve 1 in Fig. 1 is shown in an operating condition in which the solenoid ~~[[2]]~~ 3 is not energized with current, so that no magnetic forces act on the two armatures 4, 5. In this situation, the spring 7 presses the hollow armature 4 with its end sealing surface 19 against a seal seat surface 18

on the inside wall of the valve housing 2, which is associated with a connection 16 for a pressure line. Furthermore, in this situation the inner armature 5 is pressed by the spring 6 with one of its ends against a seal seat surface 14 on the inside of the hollow armature 4, so that by virtue of the inner armature 5 and an end sealing surface 13 the opening 21 in the hollow cylinder 4 is at least partly, but preferably completely closed.

[040] Fig. 2 shows the dual-action control valve 1 in the operating condition in which the solenoid 3 is energized with the maximum current envisaged. Due to the magnetic forces acting on the armatures 4, 5, both armatures are displaced upward against the restoring forces of the springs 6, 7, so that the flow path from the pressure line connection 16 to the control pressure line connection 17 is completely open. In contrast to the operating situation shown in Fig. 1, now however, now the connection ~~[[17]]~~ 15 for the return line is completely blocked by the inner armature 5, since a sealing surface 22 of the latter is against an associated seal seat surface 23 of the connection ~~[[17]]~~ 15. Fig. 2 also clearly shows the sealing means 40 arranged on the end 11 of the hollow armature 4.

[042] Such energizing of the dual-action control valve 1 is appropriate for an operating situation in which, for example, finely controlled filling of a control cylinder is desired, whereas for rapid filling the solenoid ~~[[2]]~~ 3 is energized as in Fig. 2. This makes it clear that the two armatures ~~[[3, 4]]~~, 4, 5 can be actuated separately from one another.

[047] The functions and operating behavior of the dual-action control valve, according to the invention, are made clear by Figs. 5 through 8. Fig. 5 shows the time variation of a solenoid current I and the response of the dual-action control valve in relation to the control pressure ~~[[P]]~~ pA present in the connection 17 for the control pressure line. In the first energizing phase A shown in Fig. 5, the solenoid 3 is energized with a high current I, which is sufficient to raise the hollow armature 4 together with the inner armature 5 against the force of the restoring springs 6, 7 until the connection 15 for the return line is closed. As

Fig. 2 also shows, this opens up a high-capacity flow path between the connection 16 for the pressure line and the connection 17 for the control pressure line, so that the build-up of the pressure ~~[[P]]~~ pA is comparatively more rapid. At the end of the energizing phase A_1 the control pressure ~~[[P]]~~ pA falls to zero during a de-energized phase B.

[048] In the actuation position of the second energizing phase C also shown in Fig. 3, the solenoid ~~[[2]]~~ 3 receives a somewhat smaller solenoid current I which is only sufficient to raise the inner armature 5 against the restoring force of the spring 7 as far as the connection 15 for the return line, so that the opening 20 of the hollow armature 4 is also left open. In this way, inside the valve inner space 28, a flow path of lesser capacity is opened between the connection 16 for the pressure line and the connection 17 for the control pressure line. Accordingly, for as long as the solenoid current I is applied, there occurs a comparatively slower build-up of the control pressure ~~[[P]]~~ pA in the connection 17 for the control pressure line.

[052] Finally, Figs. 7 and 8 show a comparison of the filling times for a cylinder of a piston-cylinder arrangement which is supplied with actuating pressure in accordance with the pressure variation of Fig. 7 via a conventional, single-action control valve 24 and in accordance with the pressure variation of Fig. 8 via the dual-action control valve 1 of the invention. From this, it can be seen clearly that with the conventional control valve (in this case having a flow cross-section diameter of 2 mm) only one valve actuation process is possible and a time t_3 lapses before a predetermined pressure ~~[[P]]~~ pA is reached.

[057] Further, at the end faces of the two armatures 39, ~~[[42]]~~ 43 restoring springs 6, 44, 45 are provided, which push these armatures to a position which closes off the connection 16 for the pressure line when the solenoid 3 is not energized.

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1 dual-action control valve
2 valve housing
3 solenoid
4 hollow armature
5 inner armature
6 restoring spring
7 restoring spring
8 open end of the hollow armature
9 end of the inner armature on the spring side
10 end of the inner armature on the opening side
11 closed end of the hollow armature
12 housing wall
13 sealing surface on the inner armature
14 seal seat surface on the hollow armature
15 connection for a return line
16 connection for a pressure line
17 connection for a control pressure line
18 seal seat surface on the valve housing
19 sealing surface on the outside of the hollow armature
20 opening
21 opening
22 sealing surface on the inner armature for the return line connection
23 seal seat on the return line connection
24 single-action valve of the prior art
25 valve housing
26 solenoid
27 armature
28 inside space of the dual-action control valve
29 inside space of the single-action valve
30 connection for a pressure line

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31 connection for a control pressure line

32 end face of the armature

33 sealing means

34 restoring spring

35 seal seat of the housing

36 connection for a return line

37 sealing surface on the armature for the return line connection

38 sidewall of the hollow armature

39 hollow armature; first armature

40 sealing means

41 sealing means

42 bore

43 second armature

44 restoring spring

45 restoring spring

46 sealing surface

47 sealing surface

48 end face

49 sealing surface

50 sealing means

51 section of housing

52 dual-action control valve

I	electric current
[[P]] pA	pressure
t	time
NW	nominal width

1-12. (CANCELED)

13. (NEW) An electromagnetic dual-action control valve (1) having a valve housing (2), with at least one magnetic solenoid (3) arranged in the valve housing, with two armatures (4, 5) arranged coaxially to one another, with respective restoring springs (6, 7) associated with each of the two armatures (4, 5), with line connections (15, 16, 17) for lines carrying a pressure medium and with sealing surfaces on the two armatures (4, 5) that can be moved by magnetic force so as to close or open the line connections (15, 16, 17), wherein a first one of the two armatures is formed as a hollow armature (4) with a closed end face (11), inside the hollow armature (4) which is arranged an inner armature (5) which can move coaxially thereto, and the hollow armature (4) has a plurality of openings (20, 21) for the pressure medium, of which a first opening (21) can be closed by a sealing surface (13) of the inner armature (5).

14. (NEW) The electromagnetic dual-action control valve according to claim 13, wherein the first opening (21) is formed in the closed end face (11) of the hollow armature (4).

15. (NEW) The electromagnetic dual-action control valve according to claim 13, wherein the restoring spring (7) for the hollow armature (4) is arranged at an end (8) of the hollow armature (4) which is opposite to the closed end (11).

16. (NEW) The electromagnetic dual-action control valve according to claim 13, wherein the restoring spring (6) for the inner armature (5) is arranged at an end (9) of the inner armature (5) which is opposite to the sealing surface (13) for closing the opening (21) of the hollow armature (4).

17. (NEW) The electromagnetic dual-action control valve according to claim 13, wherein the dual-action control valve (1, 52) is formed as a clutch control valve, which has a first connection (16) for a pressure line, a second connection (15) for a return line and a second connection (17) for a control pressure line.

18. (NEW) The electromagnetic dual-action control valve according to claim 13, wherein the dual-action control valve (1, 52) is formed as one of a switching or fixed-cycle valve, which has a first connection (16) for a pressure line, a second connection (15) for a return line and a third connection (17) for a control pressure line.

19. (NEW) The electromagnetic dual-action control valve according to claim 13, wherein at an end (9) associated with the restoring spring (6), the inner armature (5)

has an end sealing surface (22) by means of which a line connection (15) can be closed.

20. (NEW) The electromagnetic dual-action control valve according to claim 19, wherein the line connection (15) for a back-flow or return line can be closed by the end sealing surface (22) of the inner armature (5) nearest the restoring spring.

21. (NEW) The electromagnetic dual-action control valve according to claim 13, wherein a first opening (21) in the hollow armature (4) has a smaller cross-sectional area than cross-sectional areas of the connection (16) for at least one of the pressure line and the connection (17) for the control pressure line.

22. (NEW) The electromagnetic dual-action control valve according to claim 13, wherein the two armatures (39, 43) are arranged axially one behind the other, one armature is formed as a hollow armature (39) with an axial bore (42), the axial bore (42) is directed coaxially to the connection (16) for a pressure line, the hollow armature (39) has a first sealing surface (46) by means of which the connection (16) can be closed in a pressure-tight way, and at an end of the hollow armature (39) opposite the first sealing surface (46) is formed a second sealing surface (47), against which the first end face (48) of the second armature (43) facing toward the hollow armature (39) can be brought into contact to close off the axial bore (42), and the second armature (43) has at an end facing away from the hollow armature (39), a second sealing surface (49), by means of which a further connection (15) for a return line can be closed.

23. (NEW) The electromagnetic dual-action control valve according to claim 13, wherein between one of the sealing surfaces and the ends of the armatures (39, 43) or the valve housing (2) are arranged sealing means (50), preferably sealing rings.

24. (NEW) The electromagnetic dual-action control valve according to claim 13, wherein a second armature (43) is guided axially by a section (51) of the housing.